(19) JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: 2003050145 A
(43) Date of publication of application: 21.02.2003

(51) Int. Cl G01F 1/66
G01P 5/00

(21) Application number: 2001240325
(22) Date of filing: 08.08.2001

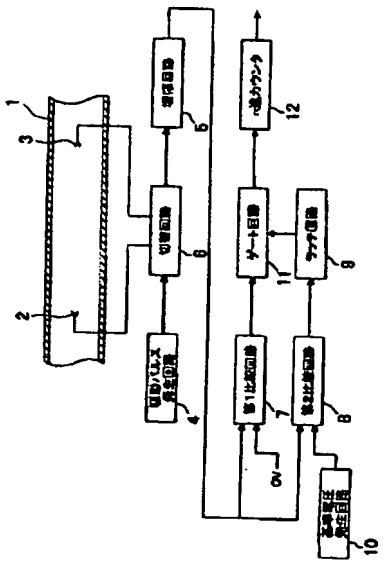
(71) Applicant: KANSAI GAS METER CO LTD
RICOH ELEMEX CORP
(72) Inventor: ESHITA KAZUO
NAKAMURA EIJI
KONO AKIO
YASUDA TETSUYA

(54) METHOD AND APPARATUS FOR ULTRASONIC FLOW-VELOCITY MEASUREMENT

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a method and an apparatus for an ultrasonic flow-velocity measurement where the arrival timing of ultrasonic waves for measuring a propagation time difference can be specified with full accuracy, and a full measurement accuracy can be ensured.

SOLUTION: The ultrasonic waves are generated and transmitted from an ultrasonic transducer 2 and an ultrasonic transducer 3 arranged on the upstream side and the downstream side of a measuring fluid, flowning in an ultrasonic flow-velocity measuring tube 1, the transmitted ultrasonic waves are received mutually, and a flow velocity is measured, on the basis of the difference in the propagation times between the ultrasonic waves found by comparing respective received waves W. By specifying the time at which second waves in the first half part of the received waves W reach a reference voltage value Vth, their reception is determined, the prescribed number of waves is counted from the time at which the received waves W reach the reference voltage value, and the zero-crossing point of time of maximum-amplitude waves Wm, after counting the prescribed number of waves, is regarded as the arrival timing of the ultrasonic waves for measuring the propagation time difference.



[JP,2003-050145,A]

CLAIMS

[Claim(s)]
[Claim 1] While arranging an ultrasonic transducer, respectively to the upstream [of the Measurement Division fluid which flows through the ultrasonic flow-velocity measuring pipe], and lower stream side and carrying out birth transmission of the supersonic wave mutually from said each ultrasonic transducer In the ultrasonic flow-velocity measuring method which measures the flow velocity based on the difference of the propagation time of the supersonic wave which received the transmitted supersonic wave mutually and was searched for from the comparison of each received wave By specifying the event of the wave for the first portion of said received wave reaching a reference value, perform a receipt-of-letter judging and a predetermined wave number is counted from the reference-value attainment event of the received wave. The ultrasonic flow-velocity measuring method characterized by making the zero cross event of the peak swing wave after the predetermined wave-number count, or the wave of the neighborhood into the ultrasonic reaching timing for propagation time difference determination.
[Claim 2] While an ultrasonic transducer is arranged at the upstream [of the Measurement Division fluid which flows through the ultrasonic flow-velocity measuring pipe], and lower stream side, respectively and carrying out birth transmission of the supersonic wave mutually from said each ultrasonic transducer In the ultrasonic flow-velocity measuring device which measures the flow velocity based on the difference of the propagation time of the supersonic wave which received the transmitted supersonic wave mutually and was searched for from the comparison of each received wave A receipt-of-letter judging means to perform a receipt-of-letter judging by specifying the event of the wave for the first portion of said received wave reaching a reference value, A count means to count a predetermined wave number from the reference-value attainment event of the received wave, The ultrasonic flow-velocity measuring device which is equipped with the timing specification means which makes the zero cross event of the peak swing wave after the predetermined wave-number count, or the wave of the neighborhood the ultrasonic reaching timing for propagation time difference determination, and is characterized by things.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the ultrasonic flow-velocity measuring method and apparatus which measure the flow velocity of gas and other fluid using a supersonic wave.
[0002]
[Description of the Prior Art] Conventionally, it faces in quest of gas and other fluid flow, and the continuous thing for which it is, and it carries out, and measures periodically, and a discharge is calculated based on this is first performed in the flow velocity of the fluid. And the approach using a supersonic wave is known as one of the

flow-velocity measuring methods of such fluid.
[0003] It is as follows when drawing 3 explains the principle of this ultrasonic flow-velocity measuring method. In drawing 3 , (1) is the ultrasonic flow-velocity measuring pipe with which fluid, such as gas, flows through a core. In this ultrasonic flow-velocity measuring pipe (1), predetermined distance is separated and an ultrasonic transducer (2) and (3) are arranged at the upstream [of the direction of flow], and lower stream side. While this ultrasonic transducer (2) and (3) are driven by the driving pulse from a drive pulse generation circuit (4), they vibrate and birth transmission of the supersonic wave is carried out, it is what receives the transmitted supersonic wave. It is outputted from a receiving amplifier (5) in the received wave when the ultrasonic transducer (3) and (2) vibrate.
[0004] And propagation time until the supersonic wave transmitted to the direction of easy flow from the ultrasonic transducer by the side of the upstream (2) to flow is received with the ultrasonic transducer by the side of the lower stream (3), [the difference with propagation time until the supersonic wave transmitted to the reverse direction from the ultrasonic transducer by the side of the lower stream (3) to flow is received by the ultrasonic transducer by the side of the upstream (2)] Since [/ flow velocity], the flow velocity of the fluid is measured by carrying out using a clock wave etc. and searching for the propagation time difference of this supersonic wave.
[0005] In addition, it is the switching circuit where (6) changes bonding of each ultrasonic transducer (2), (3), a drive pulse generation circuit (4), and a receiving amplifier (5) in drawing 3 . A drive pulse generation circuit (4), and the ultrasonic transducer by the side of the upstream (2), the ultrasonic transducer by the side of the lower stream (3) and a receiving amplifier (5) are connected first. After measuring the propagation time from the upstream side to the lower stream side, by actuation of this switching circuit (6) The ultrasonic transducer (3) by the side of a drive pulse generation circuit (4) and the lower stream, It changes so that a receiving amplifier (5) may be connected with the ultrasonic transducer by the side of the upstream (2), and the propagation time from the lower stream side to the upstream side is measured.
[0006] By the way, in order to measure the propagation time of a supersonic wave, it is necessary to specify ultrasonic reaching timing in the received wave (W) outputted from a receiving amplifier (5). And a receipt-of-letter judging is performed by specifying the event of the wave (especially initial wave) for the first portion of a received wave (W) reaching the reference-voltage value Vth for the first time, as conventionally shown in drawing 4 . The next zero cross event (Z') was made into ultrasonic reaching timing the event of the received wave (W) reaching the reference-voltage value Vth.
[0007]
[Problem to be solved by the invention] However, the received wave (W) outputted from a received wave amplifier (5) may receive interference of the reflected wave of the supersonic wave at the time of determination, ambient noise, etc. last time, and the zero cross event may be changed. [floating at the zero cross event of this received wave (W)] Although the amplitude is small by the wave of a large part like a peak swing wave or the wave of the neighborhood, like the wave for the first portion (especially initial wave) Since the amplitude is large by the wave of a small part, In some which make the zero cross event (Z') of the wave for the first portion of a received wave (W) ultrasonic reaching timing like before, there was a problem that ultrasonic reaching timing could not

be specified with sufficient accuracy.
[0008] By specifying the event of the peak swing wave of a received wave (W) or the wave of the neighborhood reaching a reference-voltage value for the first time from the first, a receipt-of-letter judging is performed and making the next zero cross event into ultrasonic reaching timing the event of the received wave (W) reaching a reference-voltage value can think. However, there was a problem that a peak swing wave or the wave of the neighborhood had the quite small amplitude difference of adjacent waves, and it was difficult to perform a receipt-of-letter judging on the basis of the same wave.
[0009] This invention aims at offer of the ultrasonic flow-velocity measuring method which it is made in view of an above-mentioned problem, and the ultrasonic reaching timing for propagation time difference determination can be specified with sufficient accuracy, as a result can secure sufficient accuracy of measurement, and an apparatus.
[0010]
[Means for solving problem] [the ultrasonic flow-velocity measuring method concerning this invention] in order to attain the above-mentioned object While arranging an ultrasonic transducer, respectively to the upstream [of the Measurement Division fluid which flows through the ultrasonic flow-velocity measuring pipe], and lower stream side and carrying out birth transmission of the supersonic wave mutually from said each ultrasonic transducer In the ultrasonic flow-velocity measuring method which measures the flow velocity based on the difference of the propagation time of the supersonic wave which received the transmitted supersonic wave mutually and was searched for from the comparison of each received wave By specifying the event of the wave for the first portion of said received wave reaching a reference value, perform a receipt-of-letter judging and a predetermined wave number is counted from the reference-value attainment event of the received wave. It is characterized by making the zero cross event of the peak swing wave after the predetermined wave-number count, or the wave of the neighborhood into the ultrasonic reaching timing for propagation time difference determination.
[0011] Since the amplitude difference of the adjacent waves in a received wave performs a receipt-of-letter judging by the wave for the large first portion according to this, a receipt-of-letter judging can always be performed on the basis of the same wave. And further since the zero cross event of the peak swing wave after a predetermined wave-number count or the wave of the neighborhood is made into ultrasonic reaching timing from the reference-value attainment event of a received wave There is almost no floating at the zero cross event by interference of the reflected wave of the last determination, ambient noise, etc., and the ultrasonic reaching timing for propagation time difference determination can be specified with sufficient accuracy. In addition, the wave for the first portion of this received wave means the wave before the wave near the peak swing wave of a received wave.
[0012] [moreover, the ultrasonic flow-velocity measuring device concerning this invention] While an ultrasonic transducer is arranged at the upstream [of the Measurement Division fluid which flows through the ultrasonic flow-velocity measuring pipe], and lower stream side, respectively and carrying out birth transmission of the supersonic wave mutually from said each ultrasonic transducer In the ultrasonic flow-velocity measuring device which measures the flow velocity based on the difference of the propagation time of the supersonic wave which received the transmitted supersonic

wave mutually and was searched for from the comparison of each received wave A receipt-of-letter judging means to perform a receipt-of-letter judging by specifying the event of the wave for the first portion of said received wave reaching a reference value, A count means to count a predetermined wave number from the reference-value attainment event of the received wave, [according to this which is equipped with the timing specification means which makes the zero cross event of the peak swing wave after the predetermined wave-number count, or the wave of the neighborhood the ultrasonic reaching timing for propagation time difference determination, and is characterized by things] The ultrasonic flow-velocity measuring method according to claim 1 is certainly [simply and] realizable.

[0013]

[Mode for carrying out the invention] Drawing 1 shows the ultrasonic flow-velocity measuring device for carrying out this invention.

[0014] The ultrasonic transducer with which it has been arranged by (1) separating predetermined distance to the upstream [of the direction of flow], and lower stream side in drawing 1 , as for the ultrasonic flow-velocity measuring pipe, (2), and (3), The receiving amplifier where (4) outputs a received wave when the drive pulse generation circuit which generates a driving pulse, and (5) receive a supersonic wave by an ultrasonic transducer (2) and (3), (6) is a switching circuit which changes bonding of each ultrasonic transducer (2), (3), a drive pulse generation circuit (4), and a receiving amplifier (5), and these of it are the same as that of what was shown in drawing 3 .

[0015] In this embodiment, the 1st comparison circuit (7) is established in the output side of the receiving amplifier (5). This 1st comparison circuit (7) outputs a received wave (W) and the square wave (K) of this period, whenever it compares with 0V the received wave (W) outputted from a receiving amplifier (5) and a received wave (W) exceeds 0V, as shown in drawing 2 (a) and (b). This square wave (K) is used when it corresponds to a received wave (W), it is continuously outputted if it is **, and counting the wave number of a received wave (W) in the below-mentioned n ** counter (12), since it is a received wave (W) and this period.

[0016] Moreover, similarly the 2nd comparison circuit (8) and latch circuitry (9) are established in the output side of the receiving amplifier (5). The received wave (W) outputted from a receiving amplifier (5) as this 2nd comparison circuit (8) is shown in drawing 2 (a), When the reference-voltage value Vth outputted from circuit generating reference voltage (10) is compared and a received wave (W) reaches the reference-voltage value Vth for the first time, a receiving decision signal is outputted, and thereby, the receipt-of-letter judging of a supersonic wave is performed. In this embodiment, as the 2nd wave (W2) of a received wave (W) falls, the reference-voltage value Vth is set up to reach the reference-voltage value Vth.

[0017] Moreover, latch circuitry (9) outputs a gate pulse (G), when the receiving decision signal has been transmitted from the 2nd comparison circuit (8) as a closed state is taken and it is shown in drawing 2 (c) unless a receiving decision signal is transmitted from the 2nd comparison circuit (8).

[0018] The gate circuit (11) is prepared in the output side of the 1st comparison circuit (7) and latch circuitry (9). As shown in drawing 2 (d), when a gate pulse (G) is outputted from latch circuitry (9), this gate circuit (11) passes the square wave (K) outputted from the 1st comparison circuit (7), and extracts a next square wave (K) the event of a received

wave (W) reaching the reference-voltage value Vth.
[0019] n ** counter (12) is formed in the output side of the gate circuit (11). When this n ** counter (12) counts the square wave (K) which has passed the gate circuit (11) as shown in drawing 2 (e) and the predetermined wave-number (this embodiment two waves) count of these square waves (K) is carried out, That is, after starting the count of a square wave (K), the time of the square wave (K) of eye three waves rising is made into ultrasonic reaching timing, and an ultrasonic attainment impulse wave (J) is outputted. The predetermined wave number (two waves) of this square wave (K) is equivalent to the wave number from the 2nd wave (W2) of a received wave (W) to a peak swing wave (Wm), and when the 3rd wave of a square wave (K) attends, it is in agreement with (Z) at the zero cross event of the peak swing wave (Wm) of a received wave (W).
[0020] Next, the ultrasonic flow-velocity measuring method using the apparatus shown in drawing 1 is explained.
[0021] First, a driving pulse is generated in a drive pulse generation circuit (4). By impressing it to the ultrasonic transducer by the side of the upstream (2), a supersonic wave is transmitted from an ultrasonic transducer (2), the ultrasonic transducer by the side of the lower stream (3) receives the transmitted supersonic wave, and a received wave (W) is outputted from a receiving amplifier. This received wave (W) is the oscillatory wave form which the amplitude decreases soon, after the 2nd wave (W2), the 3rd wave (W3), and the amplitude become large rather than the 1st wave (W1), as shown in drawing 2 (a). The amplitude difference of the waves which adjoin each other by the wave for the first portion (especially early wave) is large, and the amplitude difference of adjacent waves is small by the peak swing wave (Wm) and the wave of the neighborhood.
[0022] In the 1st comparison circuit (7), as shown in drawing 2 (a) and (b), whenever it compares with 0V the received wave (W) outputted from a receiving amplifier (5) and a received wave (W) exceeds 0V, a received wave (W) and the square wave (K) of this period are outputted.
[0023] The received wave (W) outputted from a receiving amplifier (5) on the other hand in the 2nd comparison circuit (8) as shown in drawing 2 (a), When the reference-voltage value Vth outputted from circuit generating reference voltage (10) is compared and a received wave (W) reaches the reference-voltage value Vth, a receiving decision signal is transmitted, and this performs the receipt-of-letter judging of a supersonic wave. Thus, since the amplitude difference of adjacent waves performs a receipt-of-letter judging by the wave for the large first portion (this embodiment the 2nd wave), a receipt-of-letter judging can always be performed on the basis of the same wave (the 2nd wave).
[0024] In latch circuitry (9), as shown in drawing 2 (c), when a receiving decision signal is transmitted from the 2nd comparison circuit (8), a gate pulse (G) is outputted.
[0025] In a gate circuit (11), as shown in drawing 2 (d), when a gate pulse (G) is outputted from latch circuitry (9), the square wave (K) outputted from the 1st comparison circuit (7) is passed, and a next square wave (K) is extracted the event of a received wave (W) reaching the reference-voltage value Vth.
[0026] As shown [n ** counter (12)] in drawing 2 (e), when the square wave (K) which has passed the gate circuit (11) is counted and the predetermined wave-number (two waves) count of these square waves (K) is carried out, That is, after starting a count, the time of the square wave (K) of eye three waves rising is made into ultrasonic reaching

timing, and an ultrasonic attainment impulse wave (J) is outputted. Thus, since (Z) is made into ultrasonic reaching timing at the zero cross event of a peak swing wave (Wm) There is almost no floating of (Z) at the zero cross event by interference of the reflected wave of the last determination, ambient noise, etc., and the received wave (W) reaching timing for propagation time difference determination can be specified with sufficient accuracy.

[0027] The rest finds the time from the event of a supersonic wave being transmitted using a clock wave etc. to receiving reaching timing as propagation time tau of the supersonic wave of a direction of easy flow.

[0028] After [in this way,] finding the propagation time tau of the supersonic wave of a direction of easy flow It changes so that a drive pulse generation circuit (4), and the ultrasonic transducer by the side of the lower stream (3), the ultrasonic transducer by the side of the upstream (2) and a receiving amplifier (5) may be connected by actuation of a switching circuit (6), and it asks for ultrasonic propagation time tau' of a reverse direction like ****. Since the propagation time difference (tau-tau') which changes according to the flow velocity has arisen, the propagation time tau of the supersonic wave of these directions of easy flow and a reverse direction and tau' search for the flow velocity of the fluid based on this propagation time difference (tau-tau'), and calculate the fluid flow if needed further.

[0029] In addition, in this embodiment, although the 2nd wave (W2) of the received wave (W) was used for the receipt-of-letter judging, you may use the wave for the first portion of others of a received wave (W).

[0030] Moreover, although (Z) was made into ultrasonic reaching timing at the zero cross event of the peak swing wave (Wm) of a received wave (W), it is good also considering the zero cross event of the wave near the peak swing wave (Wm) as ultrasonic reaching timing.

[0031] Moreover, although the predetermined wave number counted in n ** counter (12) was made into two waves, you may change according to a received wave's (W) own characteristic and the wave for the first portion of the received wave (W) used for a receipt-of-letter judging. For example, what is necessary is just to let the predetermined wave number to count be n wave, if the wave number from the wave used for the receipt-of-letter judging in a received wave (W) to a peak swing wave or the wave of the neighborhood is n wave.

[0032] Moreover, although propagation time of the supersonic wave was made into the time from the event of a supersonic wave being transmitted to ultrasonic reaching timing, it is good also as time of the event of subtracting or adding predetermined time to ultrasonic reaching timing from the event of a supersonic wave being transmitted. For example, it is good by subtracting predetermined time from received wave (W) reaching timing also considering the time of the event of the supersonic wave being first received from the event of asking for the event of a supersonic wave being received first, and a supersonic wave being transmitted as propagation time of a supersonic wave.

[0033] Moreover, are not limited to the above-mentioned circuit configuration, and by specifying the event of the wave for the first portion of a received wave (W) reaching a reference value, perform a receipt-of-letter judging and a predetermined wave number is counted from the reference-value attainment event of the received wave (W). As long as it makes the zero cross event of the peak swing wave after the predetermined wave-

number count (Wm), or the wave of the neighborhood into the ultrasonic reaching timing for propagation time difference determination, you may be other circuit configurations.
[0034]
[Effect of the Invention] Since the amplitude difference of the adjacent waves in a received wave performs a receipt-of-letter judging by the wave for the large first portion according to invention concerning Claim 1, a receipt-of-letter judging can always be performed on the basis of the same wave. And further since the zero cross event of the peak swing wave after a predetermined wave-number count or the wave of the neighborhood is made into ultrasonic reaching timing from the reference-value attainment event of a received wave It becomes possible for there to be almost no floating at the zero cross event by interference of the reflected wave of the last determination, ambient noise, etc., and to be able to specify the ultrasonic reaching timing for propagation time difference determination with sufficient accuracy, as a result to secure sufficient accuracy of measurement.
[0035] According to invention concerning Claim 2, the ultrasonic flow-velocity measuring method according to claim 1 is certainly [simply and] realizable.

[Translation done.]